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AND

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CONTINENTAL WATER METER COMPANY,

BOSTON, MASS.

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No. 18 POST OFFICE SQUARE.
1881.

CONTINENTAL WATER METER COMPANY.

Incorporated 1880.

CAPITAL STOCK, ... $500,000

P. A. COLLINS, President.

JOHN D. GOULD, Treasurer and Manager.

OFFICE: 95 MILK STREET, BOSTON, MASS.

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THE PRESERVATION

OF A

PURE WATER SUPPLY,

Is the subject of earnest consideration in our thickly settled towns and cities. Of the three great essentials of life — *air*, *water*, *and food* — the second named may be regarded not only as the chief constituent part of man, but also as peculiarly under his care and control. *Seventy-five per cent.* of his whole body is made up of the elements of water; *ninety-five per cent.* of the healthy blood which flows in his veins is water; and more than *eighty per cent.* of the foods which give him life and strength is water. In its agencies, too, water is marvellous. In its purity it is a priceless blessing, and in its abundance the ready servant of the useful and mechanical arts; while, on the other hand, its loss admits no substitution, and in its pollution it becomes the wide-spreading source of pestilence and death.

GROWTH OF WATER SUPPLY.

Man in his relations to the use of water ma be said to have reached three periods in ever settled country. The first period is that o mere settlement, when man in his isolatio instinctively seeks the protection of nature an fixes his habitation near some basin or flow o water.

The second period is that of aggregation. Men are drawn together by mutual interests, and communities spring up and grow until the individual want and pleasure yield to the public good. Then it may become necessary to expend large sums in the acquisition and distribution of water. This may be a demand of luxury, as when ancient Rome in the opulence of her power built her famous baths and provided a supply of three hundred gallons of water per diem for each individual; or it may be a necessity of commerce, as when Constantinople in the fifth century gathered the habitable world to her borders, and was equally liberal with her Latin sister in the use of water. From whatever motive, it is certain that the simple necessities and desires of men have induced great enterprises for water supply and distribution, as is witnessed by the stupendous structures of the Middle Ages, as well as by the no less wonderful triumphs of the engineer in our own day and country.

The third period is when the aggregation of men becomes a manufacturing centre and a great metropolis. The intermittent life of the mere trader is lost, and the fixity of tenure of the producer is established. "Population increases; the mass of buildings thickens; the lands upon which the town is built become saturated with sewage, and the individual sources within the town are polluted; the atmosphere over and within the town is fouled by gases arising therefrom; and the dangers of epidemics, fevers, and contagious diseases increase." Moreover, many manufacturing enterprises are absolutely dependent upon an abundant supply of pure water, while the comfort and luxury born of prosperity equally demand the same. In another relation, also, the same necessity arises, and that is, when some particular enterprise of great character and profit — such as mining — attracts men to localities where a supply of pure water is obtained only by the greatest trouble and cost.

Here the preservation of a pure water supply is not only a difficult scientific problem, but upon the solution of that problem depends the very existence of men as well as the success of their enterprises. This third period has arrived to many communities in this country; and it is proposed herein to briefly discuss the difficulties surrounding them, especially our thickly settled towns and cities, and to suggest a remedy.

PRESENT DEMANDS.

It will be conceded that many towns and cities have reached the extreme of what scientific engineering can do for them in the way of *acquiring* a water supply, since nature herself shows a limit, and that nearly all have made an outlay for their supply which *should* be sufficient for present and future population for many years to come. Yet it is a fact that in many cities and towns the water supply is impure and imperfect, and that public safety and private comfort are thereby seriously threatened. To quote the words of Fanning, in his great treatise upon Water-Supply Engineering: "When people have become accustomed to the ready flow from the faucets, at the sinks and basins, and in the shops and warehouses, then, if the pumps cease motion or the valve is closed at the reservoir, the household operations from laundry to nursery are brought to a standstill; engines in the shops cease motion; hydraulic hoists and motors in the warehouses cease to handle goods; railway trains, ocean steamers, and coasters delay for water; and a general paralysis checks the busy activity of the city. What a thrill is then given by an alarm of fire!" Now, what is to be done? Civilization does not retreat; and since men have enjoyed the advantages of pure water and know its absolute necessity for life and prosperity, they will suffer nothing less. "When the people have learned to depend, or must of necessity depend, upon the public pipes for their indispensable water, it must flow unceasingly, as does the blood in our veins. All elements of uncertainty must be overcome." They demand of science all that it can furnish. They demand of the municipal authorities and commissioners to whom they have entrusted the management of water supplies the utmost vigilance and a determined effort to prevent the dangers which threaten.

WASTE.

If it is conceded that the present water supply should provide for the natural and proper wants of our cities and towns, then the inquiry seems pertinent: Why is the supply constantly threatened and often inadequate? The answer is, *Because of reckless and careless waste.* After every allowance is made for evaporation and for loss by defective mains and imperfect distributing appliances, it is found that only a small percentage of the total loss has been accounted for. Rigid investigation and long experience have established beyond question the fact that the great source of loss is waste. So well known is this fact that it seems almost superfluous to adduce proof; but, nevertheless, several reliable authorities may be quoted. Joseph P. Davis, City Engineer of Boston in 1878, made an exhaustive search into the cause of insufficient water supply, and in his Annual Report for that year showed conclusively that about *one-half* of all the water supplied to the city of Boston was wasted.

The Superintendent of the Water Works of the city of Pittsburg, Penn., in his Report for the year ending Jan. 31, 1880, says: —

"It is the experience of most cities where water works have been long established, that wastefulness in the use of water, on the part of consumers, has become so great a percentage of the total supply, that almost any expenditure is warranted to reduce it within reasonable limits. If such a waste should be allowed to continue, enlargement of works and increased expenditures will be needful to keep up with the demands. From careful experiments, made in this country and in Europe, it has been demonstrated that where water is freely used by all classes, and waste prevented, forty-five gallons per capita was estimated to be sufficient to cover all purposes, including fire. These data have been used by mechanical engineers in estimating the amount required by different cities in erecting water works. And when the demand overreached this, it was traced almost exclusively to waste.

"The waste of water involves a large pecuniary loss, being at least one-third of the amount delivered into our reservoir; therefore, the adoption of some means by which this profligate use of water may be avoided is a subject deserving of serious consideration. Consumers are only willing to pay for a limited quantity of water, but wish to use an unlimited amount. There is no doubt but most of our consumers use or waste two or three times more water than their needs demand. This great waste is due to the wanton disregard, on the part of consumers, to the public interest, and a mistaken view as to the obligation of the city in undertaking to supply them with water. The city only undertakes to supply them with sufficient for domestic and other legitimate uses, precisely as a private firm would do, except that the city does not aim at any profit in the transaction, but has fixed water rates suggested by different demands. The revenue derived from this source is to support the works and liquidate its indebtedness. It must be borne in mind that each gallon of water wasted requires additional expense to replace it.

"The fact has been made apparent that, like all other water works, we are suffering from the constantly increasing waste of water. We find that after using the greatest possible diligence in endeavoring to protect the waste of water, our rules and regulations are disregarded, and that mostly by the parties from whom we should expect most assistance in enforcing them. Where wealth and intelligence are combined, we often find parties using water as if it had no intrinsic value, and apparently ignoring the fact that others have rights which they refuse to recognize."

The Executive Board of the Water Works

of Rochester, N. Y., in their Annual Report for the year ending April 1, 1880, observe: —

"Attention is called to the fact that a large amount of water is wasted by consumers. This practice should be sternly repressed, as it results in serious loss of pressure obtained for the suppression of fires, and is a habit that should be discontinued before it becomes so settled as to lead to the most serious consequences. Any citizen who indulges in this practice is committing a fraud on his neighbor, and is appropriating a valuable thing for which he does not pay, and which is not his."

REMEDY.

Inasmuch as the discussion of waste is generally attended by some suggestions in regard to its prevention, it will be convenient, before quoting other authorities upon this subject, to take the above premise for granted; viz., *that waste is the cause of failure of water supply*, and at once proceed to seek a remedy. The gravity of this question is apparent, and is occupying, as the various Water Board Reports clearly show, the attention of the whole country. All mankind are prone to waste, and especially to waste whatever costs them little or nothing. The hunter kills more than he can eat or carry away, solely from wantonness. In short, waste is in human nature. This great and growing evil can only be met and overcome by an appeal to another principle, equally strong in human nature — the love of gain. The consumer must, as for all other articles, pay for the water which he uses. Let him be free to waste as much as he will; but let him be made to pay for what he wastes as well as what he rightfully uses. That this mode of correcting this evil is not mere theory, is abundantly proved by comparison of the amount of water daily consumed in cities which have adopted this idea with the amount consumed in those that have not. The remedy is apparent; but will the people submit to it? They will most readily, as soon as they are made to realize the justice of it and the personal profit they may derive from it. People do not waste to any great extent the milk, the gas, the ice, the coal, and the wood which they pay for: why do they then actually waste one-half the whole water supply, if not more? Because it makes no difference, is their reply. But it does make the difference, let them learn, of additional millions expended in new water works, and in consequent additional taxation. The people have only to know this, and to see the injustice of one person's paying for the waste and improvidence of another, and in the end they will themselves demand it as a right—to pay only for what they use. History records the fact that the ancients imposed a fine of a pound of gold for every ounce of water surreptitiously or wastefully taken. No less carefully should the citizen of to-day guard that upon which his individual comfort and health, and the public safety and prosperity depend. To the question, What is the best remedy for this waste? we reply, A system of correct meter measurement. After years of trial the old schemes for intercepting and preventing waste have been abandoned. The system of meter measurement is rapidly coming to the front as the only method which effectually prevents the evil complained of, and with equal justice to all parties. It is *the only method by which the responsibility for waste is fixed upon the actual culprit.* Humber in his great work upon Water Supplies, says:—

"When the increasing size of a town renders it necessary to economize the supply of water at it disposal, or when the acquisition is expensive, a it is for instance by pumping, the great differenc in its consumption by various consumers shows th desirability of possessing an instrument that ca measure separately the quantity used by each party."

In resuming our examination of the questio of waste, and in support of the assertion that a system of correct meter measurement is the best method of suppressing waste, careful attention is invited to the verdict of the best authorities upon the subject; viz., the Water Boards of our cities and towns.

The Commissioner of Public Works for the city of New York, in his Report for the quarter ending March 31, 1880, says: —

"The most important step, however, which has been taken towards the suppression of waste, is the introduction of the meter system, under which water meters are being placed upon all buildings and establishments where water is used in large quantitie and for business purposes, other than privat houses, which are exempt by law from the application of meters. It is only within a recent period that meters have been applied to any considerabl extent. On Jan. 1, 1876, there were in all 275

On August 1, 1879, there were 609, and at this date there are 1,976, which number will be increased to about 3,500 by the close of the year. As the larger establishments have been first metered, the good effects of the system are even now quite evident, and as the work is to be continued without intermission until all business places are metered, very great improvements are anticipated within the next two years.

"The meters now in use are distributed among various establishments as follows:—

On railroads,	121	meters.
On hotels,	298	"
On slaughter and packing houses,	111	"
On breweries and malt houses,	154	"
On stables,	498	"
On gas companies,	33	"
On bottling establishments,	62	"
On docks,	93	"
On miscellaneous places,	606	"
Total,	1,976	meters.

"As instances of the saving of water effected by meters, I will cite two cases. One large hotel which, on the first application of a meter, was found to be consuming, or, rather, wasting, 115,000 gallons of water daily, is now reduced to 45,000 gallons, and another has fallen from 80,000 gallons to 24,000 gallons daily. In the case first cited resort was had to the aid of a well, but in the second the saving was entirely from stoppage of waste. Some manufacturing establishments, such as breweries, have bored for water since the introduction of meters, the well water being used for washing and cooling purposes. I would be very glad if our water supply could be increased from subterranean sources, as the Croton service and pressure would be benefited thereby. The success in boring, however, has not been very great, and the water thus obtained is not pure, and can only be used for cleaning, cooling, etc.

"There is no doubt that great waste takes place in private houses, and I have under consideration, and in fact already on trial, some methods for controlling such use of water without placing meters within the premises. In official reports I have suggested that a stringent law should be passed giving to the Department of Public Works supervision of buildings in respect to the matter of plumbing and water pipes. If pipes are properly placed within the buildings so as to prevent freezing, the pernicious habit of allowing water to run to waste to guard against frost would be broken up. We are now placing stop-cocks in the service-pipes of several houses at the curb line, so that, by the application of a portable waste-water gauge devised by Mr. B. S.

Church, Resident Engineer of the Croton Aqueduct, the quantity of water per hour rnnning into the house is accurately indicated upon the face of the instrument. It may be practicable, also, to place a small portable meter within a box near the curb, which could be locked up and left for a few days, so that the amount of water consumed (or wasted) within the house can be correctly ascertained. By some method of this kind a large saving of water will be effected. The knowledge of every householder that the Department has the power at any time, night or day, to ascertain the measure of waste going on, and for which proper penalty will be exacted, will induce all to protect their plumbing, and to avoid all drafts upon the water except for necessary purposes. A system to accomplish the same thing has been tried in Liverpool and some other cities of Great Britain, known as the Deacon system, and with good effect. I had this system investigated by the engineers of the Croton Bureau, but the arrangement of our water pipes being radically different from those of Liverpool, the system is not applicable here. The plans above described, of which trials are now being made, will accomplish the desired end more simply and directly. The great object in either mode is to bring a moral pressure upon householders to avoid waste, from the fact that an unseen agent, in the shape of a waste gauge or a hidden meter may, at any time, be taking note of unlawful waste.

"With this system for checking waste at private houses fairly introduced, in addition to the general appliance of meters to business places, as heretofore described, the resulting benefit will be very great. The Croton Aqueduct delivers 95,000,000 gallons daily, and can deliver no more; therefore, this amount only can be distributed daily. Now, if by suppressing waste in the manner proposed and now being adopted, one-third of the quantity now distributed can be saved for useful purposes (and many claim that the proportion will be greater), the saving would be equivalent to the addition of over thirty million gallons daily to the supply, and would have the effect of increasing the pressures in all parts of the city, and of postponing for several years the construction of an expensive aqueduct.

"For a number of years past the winter season has been the most trying period in respect to keeping up an adequate water supply, owing to the great waste which results from the custom of letting water run day and night from the faucets to prevent freezing in the pipes. The past winter has been exceptionally mild, and the occasion for such waste has been less than in former years, yet there is no doubt that it has been practised to a considerable extent during the past three months. The revival of business, manufactures, and commerce, increase of buildings and population, and extension of elevated railroads have added largely to the legitimate demand for water. We have no new elements of supply to meet these new elements of consumption. The fact that the pressures in the delivery of water have not only been maintained but improved, and the supply in the city reservoirs increased, is therefore due to the use of meters (though as yet very limited), and to the other measures adopted by the Department for the suppression of waste, and it gives assurance of the most favorable results from a further extension of the meter system to all the places to which t is applicable under the law.

"The number of meters placed during the three months is 414, and the number in use at the close of the quarter is 1,812.

"Towards the close of the quarter the meter system had been sufficiently tested to demonstrate beyond all doubt its beneficial effects in saving large quantities of water, and in view of the contemplated application of meters to all business estabishments and stables, I deemed it proper to take nto consideration the question of reducing the rate for water furnished through meters.

"From the best data obtained, we have saved by the increased use of meters the amount of the ncreased consumption of water by railroads, new buildings, manufactories, etc., during the year 1879.

"The use of meters shows that what one considers waste and saves, another keeps on using and is willing to pay for it; so that the question of where necessary use ends and waste commences is far from being settled, and that the quantity of thirty gallons per day per capita will not obtain in this city, but will be at least 100 gallons per day per capita when the supply is sufficient to reach the top stories of all buildings."

In his Report for the quarter ending June 30, 1880, he says:—

"During the quarter 532 meters were placed on various kinds of buildings, making the total number in use on the 30th of June 2,344, and at the present date about 3,000, which will be increased to 4,000 by the close of the year. This work will be continued with all practicable speed, until all places coming under the provisions in respect to meters, and where water is supposed to be wasted, are metered. The house inspections to detect leaks and waste have also been continued; 7,672 inspections were made, and 1,592 leaks in fixtures and 261 cases of wilful waste were discovered.

"The beneficial effect of these measures is now apparent, and though some inconvenience has been felt during the present extremely hot and dry summer from loss of pressure by reason of excessive use or waste, the inconvenience would have been greater but for the introduction of meters and the house inspections. In my last report I showed the saving of water which had been effected at some large hotels. The work of placing meters will be continued with all possible despatch, and I anticipate from it continuing good results.

"The average daily consumption of water in the city is now 93,500,000 gallons, or seventy-eight gallons per capita for the population of 1,208,000, given by the census of this year. Making allowance for the water used in manufactures, for shipping and other business, the consumption for domestic purposes is about sixty gallons daily per capita.

"It had long been known to the Department that considerable waste of water occurred in a certain class of large buildings occupied for various kinds of offices, and containing an unusual number of closets, urinals, and wash-basins for the convenience of the occupants. It was therefore deemed necessary to apply meters in these buildings; but some owners protested against the use of meters, claiming that they did not use water for business purposes, and that the law in reference to the compulsory use of meters did not apply to their buildings. I submitted the matter to the counsel to the corporation, who, in a clear and exhaustive opinion, sustains my view that the law authorizes the compulsory use of meters at the expense of the owner on all buildings and places where water is used, except dwellings. He also states that meters may be placed on dwellings where the Commissioner of Public Works believes waste of water to occur; the only difference being that meters on dwellings must be furnished and set at the expense of the city, while in all other cases the expense falls on the owner of the premises, and is a lien on the property."

The Chief Engineer of the Water Works of Brooklyn, N. Y., in his Report dated Jan. 29, 1880, says: —

"I do not now urge the meter-system, because our people will not tolerate the measuring out of water. But if the citizens of Brooklyn intend to consume and waste water as they do now, we must extend our works."

. . . . . .

"I admit that our people could, by care in the use of water, avoid the necessity of an immediate enlargement of our water works; but the privilege of using water is in their hands, and they will waste. We cannot stop this waste unless we meter every house, and charge for the water the same as is charged for the use of gas."

The Superintendent of the Water Works of Minneapolis, Minn., in his Report for the year ending April 1, 1880, says: —

"The wilful violations of the ordinance in regard to the uses of water by consumers, have decreased somewhat during the past year; but wilful and unintentional violations will continue, especially by paying consumers who allow non-paying to use the water on their premises, thus defrauding the city of revenue."

. . . . . .

"There seems to be no remedy for this waste and unnecessary use of water, except to institute a careful and frequent inspection, and to exact from all consumers a strict observance of existing ordinances. It is a difficult matter to adjust, as is proved by the experience of other cities.

"I am satisfied that the only just way of supplying water to consumers is through a meter at a low price per thousand gallons. By so doing the consumer pays for just what water is used, which I think would greatly lessen the quantity of consumption, and increase the revenue; and I would recommend that all large consumers be required to meter their water."

The Commissioners and Superintendent of Water Works of Pawtucket, R. I., in their Annual Report for the year ending Feb. 1, 1881, say: —

"For all purposes where the quantity of water used is variable, or dependent upon the care of employees, the board deem meter measurement the proper guide for fixing rates. This is the only device that makes the owner pay for, and consequently avoid, needless waste, and that secures to the careful the advantages resulting from economical use.

"General use of meters increases the labor of superintendence and inspection, but will tend to check reckless waste, and equalize rates. . . . . We find in some of the large cities, like Boston, Brooklyn, and New York, where they have comparatively but few meters, an excessive waste of water, and it is impossible to arrest it. The only proper way, I believe, is to measure by meter all water, and let every consumer pay for the water used. In this manner the waste will soon diminish, and the revenue increase to an extent that will surprise the most incredulous. It is said a perfect meter has not been produced. Strictly speaking, this may be true; for it is nearly if not quite impossible to construct a meter that will allow no water to pass without registry. But this gives the consumer the benefit of the loss. I would not wait for perfection, but try the best that have been produced, and am confident they will be found equal to the emergency.

"*Meters in use.* — At the 1st of April, 1880, 661 meters were reported in use in the works, as follows: 527 in Pawtucket, and 134 in Central Falls. During the past ten months 404 meters have been added to make the total 1,065; viz.:

790 in Pawtucket,
259 in Central Falls, and
16 in East Providence,

that have been paid for by the proprietors, agreeably to contract, and the proceeds have been returned to the East Providence construction appropriation."

The City Engineer of Worcester, Mass., in his Annual Report for the year ending Nov. 30, 1879, says: —

"The supply has been sufficient for all purposes. The amount drawn per day from the reservoir has now been reduced to about 2,500,000 gallons. This is largely due to the fact that meters are coming into more general use. Could a system of meter measurement be adopted, whereby every gallon of water used in the city could be so measured, I am of the opinion that it would put the question of an additional supply some years ahead, and would be a great saving of money to the city. Unless this is done, steps will have to be taken in the near future to get an additional supply. One season of drought would reduce us to the necessity of pumping, which would be a serious inconvenience and expense to the city. That water is now wasted in large quantities no one can deny. Our present daily consumption is about fifty gallons for each person; while Fall River, Providence, R. I., and Milwaukee, Wis., and other cities that have a system of meter measurement, use thirty gallons and under per day for each inhabitant. The question naturally arises, How can we reduce this waste here? I think the answer is, By the adoption of a system of meter measurement; allowing no water to be used unless so measured. This method has been eminently successful in other cities, and I can see no reason why it cannot be made a success here."

The Watuppa Water Board of Fall River, Mass., in their Annual Report dated Jan. 1, 1880, say: —

"The Water Board favors the use of meters, as we regard this method the most equitable for both parties, and more economical for the users than to pay by faucet rates; but it must be borne in mind that meters measure alike the water utilized and that allowed to run to waste.

. . . . . .

"There are no meters in public buildings, but meters are now attached to fifty-eight per cent. of the private service-pipes, and the small amount of water pumped per capita in this city is believed to be due principally to the large number of meters in use.

"The meter system is gaining in favor each year, and must eventually be almost universally adopted, in order to prevent the enormous and inexcusable waste of water which prevails in nearly every city in the country, and which is every year becoming an object of greater importance and dread. As the cities become more populous, and the country more thickly settled, the water supply will become inadequate to the demand, and more stringent methods will be necessary to prevent unnecessary waste. The fairest and most natural way of accomplishing this is to charge each one for just what he uses, and, although meters are not perfect, and will sometimes stop or get out of order, still they furnish the most satisfactory means of attaining the desired end."

The Trustees of the Water Works of Columbus, Ohio, in their Annual Report for the year ending March 31, 1879, discuss the subject of waste and its prevention as follows: —

"While we are realizing but six cents per 1,000 gallons for all the water pumped, we have received thirteen cents for that portion supplied through meters. Deducting from the total distribution the quantity made use of by the city for her public buildings and parks and for the extinguishment of fires, and the startling fact remains that the water supplied to consumers by the assessment plan nets but half the sum that a like quantity sold by measure does. At first glance it would seem that the prices as fixed by the assessment plan are too low, or that the meter rates are too high. A careful scrutiny of the books kept by the Secretary shows that neither supposition is correct. The account of nine out of every ten customers changing from the assessment plan to meter rates is reduced, and, on the other hand, not one in ten meter customers would consent to go back to the assessment plan. What, then, is the cause for these seeming contradictions? I answer, Wastage. What is the remedy? I answer, Meters. Taken as a class (for there are many exceptions), the assessment customers waste two gallons of water for every one they actually need, and, being charged for a portion of the wastage, they pay a higher water rent than their needs require. The meter customers, having to pay for all the water used, do not indulge in wastage, and thus escape being taxed for water they do not want. It is thus seen that, practically, the meter customer gets his service for a less sum than the assessment customer; and that, were the two classes both supplied by meter, the revenue from the sale of water would be reduced below what it now is.

"While this view is undoubtedly correct, it is also true that the city would be saved the cost of procuring and distributing this large excess of water, and be relieved entirely from the expense of all detective measures in regulating the use of water, thereby effecting a saving so great as to completely offset the loss, and cause the *net revenue* of the works to be largely increased. It is evident from these statements that a correct judgment cannot be formed as to the value of the water to be sold until it is possible to measure the whole quantity; then, and only then, does the price per 1,000 gallons define its cost to the consumer and the profit accruing to the city, assuming that a given revenue is to be obtained from its sale.

"In our city, the value of meters can hardly be overrated, depending, as we do, upon supplying water strictly pure and wholesome, and to obtain which we have limited ourselves to a supply furnished wholly from the filtering gallery. It is of vital importance that the wastage of water shall never cause the distribution to exceed the supply from this source, and compel the taking of the extra quantity required direct from the river, thereby vitiating the whole supply. One of two things would certainly follow the universal application of meters: either the quantity of water required for the daily supply of the city would be reduced one-half, or the revenue of the works would be doubled. In the former case, expenses would be largely reduced; and in the latter, the ability of the works to obtain the larger supply and extend the distribution would be vastly increased; and either alternative would justify an immediate and decided reduction to be made from the present rates for water."

In their Report for the year ending March 31, 1880, they say:—

"The wastage of water continues to go on, and is likely to continue so long as the present leniency is shown toward the practice, or the present method of assessment is carried on. The evil could undoubtedly be much decreased by the adoption of more severe penalties, carried out by detectives employed for the purpose; but such measures have generally been proven to be too costly, and have been, in almost all cities, abandoned after a trial for a short or long period of time, as impracticable. The regular inspectors can do much towards abating the evil, but can only partially eradicate it. Meters are, undoubtedly, the surest method; but these are expensive and liable to get out of order, especially in private residences; still their use, on the whole, is decidedly advantageous to the consumer as well as the department. The revenue from metered water in our city is largely in excess of that obtained from an equal number of customers who pay by the assessment plan, while, from the very nature of the two plans, the total wastage must be charged to the latter class. Five hundred meter customers pay a revenue of $23,436.88, while fifteen hundred assessment customers pay a sum but slightly exceeding this amount. Deducting the quantity of water furnished the city free for all public uses, and that used for the extinguishment of fires, our city can show larger receipts per one thousand gallons distributed than a vast majority of other cities.. It is a clearly established fact that cities having the greatest number of meters in use can show the largest receipts per one thousand gallons distributed. When it is possible to obtain a reliable meter at such a reasonable cost as to permit of the adoption of the plan in use by the gas company of placing a meter in every house and establishment, at the cost of the department, and receive a fixed rent therefor, it will be possible to deal out exact justice to all, and so regulate the water rates in exact accordance with the needs of the service, as to the cost of management and the required extensions to maintain its full efficiency."

The Water Commissioners of Taunton, Mass., in their Annual Report for the year ending Nov. 30, 1879, say: —

"Your Commissioners are inclined to look with favor upon the prospect of an increase in the number of consumers at meter rates."

The Executive Board of the Water Works of Rochester, N. Y., in their Annual Report for the year ending April 1, 1880, say: —

"The policy of the board in charge of the water works during the past year has been to continue the introduction of water meters in cases where it is difficult to determine the amount of water used, or where it is intended to be used intermittently."

The Collector of Water Rates in his Report to the Board of Public Works of the city of Milwaukee, Wis., dated Jan. 25, 1881, says:—

"In this connection I wish to call attention to the constant and excessive waste of water by consumers in this city. It is an unmitigated evil, which is rapidly growing more formidable and perplexing, as the service is extended, nothwithstanding the constant efforts of this office to limit such waste.

"The wise provisions made at the establishment of the works, then calculated to be sufficient to supply the city for many years to come, are now found to be quite inadequate, and greater pumping capacity has been provided for during the current year. The waste of water more than keeps pace with the necessary consumption.

"Since my accession to the office I have endeavored to use the limited authority vested in me in an earnest effort to stop the waste, and although our records show the application of a remedy in hundreds of cases during the year 1880, the evil seems to have sensibly increased. The trouble lies in our system, which the majority of our water-tax payers stigmatize as unjust—an opinion which many derive particular pleasure in ventilating at each recurring payment of a water rate. This injustice is illustrated by the opportunity, which is too often indulged in, of one consumer, with a small family, using and wasting as much water as half a dozen families of a similar size, which pay into the public treasury six times as much water tax. The careful man pays for the criminal waste of his improvident neighbor.

"There was pumped into the reservoir during the year 1879, 3,387,000,000 gallons of water. For that amount the city should have realized a revenue, at one cent per hundred gallons, of $338,700, instead of the paltry sum it did receive; to wit, $121,555. The difference between these amounts, or $217,145 per year, or $678.69 per day, very nearly represents the loss or waste. It adds nearly that sum to the annual tax roll.

"There is but one way to stop this enormous and unnecessary waste, and that is to require the use of meters at all places where they can be safely used.

"Inspection of the following table will show:

"*First.* The city of Providence with a population about equal to Milwaukee, and with 585 more service connections, uses but 2,500,800 gallons per day, while Milwaukee uses 10,603,867 gallons.

"*Second.* Providence uses 25 gallons per day for each inhabitant; Milwaukee uses 124 gallons per day for each person.

"*Third.* Providence consumes each day for each service, 337 gallons; Milwaukee, 1,551 gallons.

"*Fourth.* Providence derives a revenue of $200,039 for 2,500,000 gallons, while Milwaukee gets $121,555 for 10,603,867 gallons.

"*Fifth.* Providence receives $219 per million gallons; Milwaukee, $31.

"*Sixth.* Providence consumes 17,367 gallons per mile of pipe; Milwaukee, 123,300 gallons.

. . . .

"The reason for this vast and important difference in results in this: Providence had in use 3,203 meters; Milwaukee was content with 101.

"With us this great consumption of water is not due to growth in population nor leakage in the public mains. It arises principally from allowing water in yard hydrants, house faucets, water-closets and urinals to run without any use being made of it.

"A quarter-inch faucet will pass, at our average pressure, about 10,000 gallons in twenty-four hours, and it may be safely stated that an average of twenty-five faucets in each ward of this city are allowed to flow continually without use, thus causing a daily waste from this source of 3,250,000 gallons, worth to the tax payers of the city $325 in coal, labor and repairs.

"Families which use water only for ordinary domestic purposes consume about ten gallons per capita per day.

"The meter rates in St. Louis and Chicago are as follows:—

	St. Louis. Cents.	Chicago. Cents.
Daily average 500 gals. or less per 1,000 gals.,	35	60
Daily average 500 to 1,000 gals., . . .	33	57
Daily average 1,000 to 2,000 gals., . .	31	53
Daily average 2,000 to 3,000 gals., . .	29	50
Daily average 3,000 to 4,000 gals., . .	27	47
Daily average 4,000 to 5,000 gals., . .	25	43
Daily average 5,000 to 6,000 gals., . .	23	40
Daily average 6,000 to 7,000 gals., . .	21	37
Daily average 7,000 to 8,000 gals., . .	19	33
Daily average 8,000 to 10,000 gals., . .	17	30
Over 10,000 gals., ...	15	–

"I take it the city of Milwaukee does not desire to make money out of its citizens, but simply to furnish them pure and wholesome water at reasonable rates.

"It costs the city about five cents per 1,000 gallons to pump the water, and I would therefore respectfully suggest the adoption of a schedule of water-rates which will furnish water to manufacturers and very large consumers at a trifle more than cost, and graduate the price from that up to a reasonable charge on the smallest consumer. In my opinion the following is such a scale of rates, which, although lower than that of any other city, is sufficiently high to cover expenses, and I think will be acceptable to consumers.

"No bill to be made out for less than one dollar.

"Per 1,000 gallons, for a daily average of—

	Cents.
100 gallons or less,	40
100 gallons to 200,	35
200 gallons to 300,	25
300 gallons to 400,	20
400 gallons to 500,	15
500 gallons to 1,000,	10
1,000 gallons to 2,000,	09
2,000 gallons to 3,000,	08
3,000 gallons to 4,000,	07
4,000 gallons to 5,000,	06
Over 5,000 gallons,	05

"These rates, if accepted by consumers, and measured by meter, would decrease their water bills from thirty to fifty per cent., and if generally accepted would greatly lessen the waste, and decrease the necessity for the present enormous pumpage."

Conclusions similar to the above might be multiplied almost indefinitely, but time and space forbid. Enough have been cited to show the thoroughness of the examinations of this subject by the best engineering talent in the country, and how irresistible are the arguments in favor of meter usage.

WATER METERS.

In this connection a brief notice of water meters, their classes and qualities, will be proper. Water meters are divided into two general classes as regards their practical operation; namely, high pressure and low pressure. The high-pressure meters deliver water without any material loss of the pressure existing in the mains. The low-pressure meters deliver water without pressure, as from a cistern. There can be no question of the great superiority of high-pressure meters. Humber defines a good meter as follows: "Accurate registration, with the least possible loss of pressure or liability to become deranged, are the requisites necessary to constitute a good meter." It is evident that low-pressure meters cannot respond to the test. The necessity of cisterns in connection with low-pressure meters destroys that pressure so necessary in many kinds of trades, and so absolutely indispensable in case of fire.

High-pressure meters are subdivided into two classes; viz., Positive or Reciprocating, and Inferential or Rotary. In a positive meter a measuring chamber is alternately filled and emptied, and the number of fillings recorded, the action of the moving parts being similar to that of an engine piston. Hence the name "piston meter." Inferential meters do not actually measure the water passing through them, and registration depends upon the velocity of the current acting on a drum or turbine, which gives motion to the indicating apparatus. The best authorities pronounce the positive or piston meter to be superior to the rotary meter in every respect, whether it be in accuracy of registration, or in durability and simplicity of parts.

From the very character of its operation a rotary meter cannot have its measuring part, or piston, balanced, or subjected in all its parts to equal pressures. This inequality of pressure produces great friction, and consequently the active or valuable life of a rotary meter is short. It is also particularly affected by impurities. All waters are more or less impregnated with grit or sand, and the necessary shape and operation of a rotary meter are especially adapted to retain sediment. This soon clogs the meter, producing great wear, and finally entire stoppage, and the water passes through it in steadily increasing volume without registration.

While, therefore, the best scientific authorities are pronounced in favor of the piston meter over all others, yet there are some established principles to be observed in its construction. Especially must the piston and also the valve be perfectly balanced in regard to water pressure. In no other manner can the influences of varying pressures and sudden stoppage be resisted. In all other meters, whether diaphragm, rotary, bucket, or tilting, and in piston meters with unbalanced slide or puppet valves, the sudden arrest of the flow of water, producing a water "ram" or "hammer," imparts a vibratory motion to its particles, forces the valves from their seats, partially reverses the flow, and in consequence disarranges the registering mechanism. Such meters are absolutely worthless for strict business purposes.

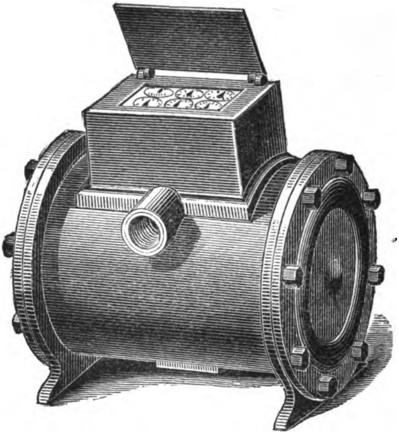
Meters have long been in use for detecting waste by aggregate users within a limited district and also where there is a considerable use of water. Until recently there has not been much effort to adapt meter measurement to dwelling-houses; but at the present time such a course is strongly urged on the one hand by the Water Boards, in the necessity which they are under to adopt at once the most stringent measures to suppress waste, and on the other hand by consumers who are unwilling to pay for the negligence and improvidence of their neighbors, and who prefer to take the only independent, just and honest course; viz., to use as much water as they are reasonably and liberally entitled to, and pay for the same.

THE CONTINENTAL WATER METER.

The Continental Water Meter Company of

Boston, Mass., have devoted special attention to the subject of water supply and its preservation, and believe that after long trial and experience they can offer in their meters the most effective means of keeping pure water for our towns and cities at the lowest possible expense. They have acquired more than twenty patents, embracing not only the latest improvements in meter construction, but also the earliest inventions which cover the fundamental principles of the piston meter. This Company, therefore, feel warranted in claiming to be the first who have reduced the manufacture of meters to a system based upon patents which control the business, and which by careful selection and development have produced the best water meter ever known. The ablest hydraulic engineers in the country as well as the best mechanical talent have long been at work for the Company, and in their present machines they claim to furnish a meter perfect in all respects, even when tried by the highest standards. The following is a brief description of the qualities of the meters now perfected and ready for general use: —

"THE BEST IN THE WORLD."



The Continental Water Meter has two working parts; viz., a cylinder piston and a valve piston, each composed of one piece of metal. There are no springs, drop-weights, cushions, ratchets, auxiliary valves, packings, or any other pieces of mechanism to wear and get out of order. As a natural result of simplicity of construction, this meter possesses the greatest possible durability. The valve is a piston perfectly balanced and moved by direct pressure upon the end, and has a compound movement partially rotating as well as horizontal. It can never be shaken from its seat or yield to varying pressures or sudden stoppages. The arrangement of the parts is such that no lodgment for sediment or other obstructing particles is offered, and both valve and piston make fewer strokes to every cubic foot of water measured than are made by any other meter. The movement is positive, and there is no dead centre. There is no pulsation, and absolute accuracy of motion is guaranteed, whether under high or low pressure. The mechanism for registration is positive, has no ratchets and pawls or other unreliable features, and is warranted to operate under every possible condition and to correctly register even the smallest quantity of water. This meter is made of the best composition, non-corrosive metal and in the most workmanlike manner. It is sold at a low price and is warranted to outlast any other meter.

Other styles more especially adapted to certain particular uses will soon be offered.

In presenting to the public the facts herein stated, the Continental Water Meter Company believe not only that the use of water meters has become a public necessity, but also that their use will prove to be both an individual and a public advantage. They respectfully solicit a careful consideration of the subject, and cordially invite an examination and trial of their meters.

TABLE

Of Units of Heads and Pressures of Water and Equivalents.

(RANKINE.)

One foot of water at 52° 3′ Fahr. = 62.4 lbs. on the sq. ft.

One foot of water at 52° 3′ Fahr. = .433 lb. on the sq. in.

One foot of water at 52° 3′ Fahr. = .0295 atmosphere.

One foot of water at 52° 3′ Fahr. = .8823 inch of mercury at 32.°

One pound on the square foot = .016026 foot of water.

One pound on the square inch = 2.308 feet of water.

One atmosphere (= 29.922 in. mercury) = 33.9 feet of water.

One in. of mercury at 32° = 1.1334 feet of water.

One cubic ft. of average sea water = 1.026 cubic ft. of pure water in weight.

One Fahr. degree = .55555 Centigrade degree.

One Centigrade degree = 1.8 Fahrenheit degree.

Temperature of melting ice = 32° on Fahr.'s scale.

Temperature of melting ice = 0 on Centigrade.

A cubic inch is equal to .004329 gallon or .0005787 cubic ft.

A gallon is equal to 231 cubic inches, .13368 cubic foot.

A cubic foot is equal to 1728 cubic inches, or 7.48052 liquid gallons, or 6.2321 imperial gallons.

The imperial gallon is equal to .16046 cubic ft., or 1.20032 U. S. liquid gallons.

A cubic yard is equal to 46,656 cubic inches, or 201.97404 liquid gallons, or 27 cubic feet.

MENSURATION OF CIRCLES AND SPHERES.

Radius, ... = 1.
Diameter, ... = Rad. × 2.
Circumference, ... = Rad. × 6.2832.
Circumference, ... = Diam. × 3.1416.
Area of circle, ... = Diam.^{2} × .7854.
Surface of a sphere, ... = Diam.^{2} × 3.1416.
Volume of a sphere, ... = Diam.^{3} × .5236.
Length of one second of arc, . = Rad. × .0000048.
Length of one minute of arc, . = Rad. × .0002909.
Length of one degree of arc, . = Rad. × .0174533.

APPROXIMATE

Bottom Velocities of flow in channels at which the following materials begin to move.

2.5 feet per second, microscopic sand and clay.
.50 feet per second, fine sand.
1.00 feet per second, coarse sand.
1.75 feet per second, pea gravel.
3. feet per second, smooth nut gravel.
4. feet per second, 1½-inch pebbles.
5. feet per second, 2-inch square brickbats.

The pressure due to a given head of water is greater within a pipe when the water is at rest than when the current is flowing through the pipe at a steady rate, for when the current is moving a portion of the force of gravity is consumed in producing that motion, and in balancing frictions.

WATER RAM.

If any valve in a line or system of water pipes can be suddenly closed while the water is flowing freely under pressure, such sudden closing of the valve will produce a strain upon the pipes far greater than that due to the static head of water. For illustration, let any delivery-pipe, having a stop-valve at its outflow end, be 1 ft. diameter $= d_1$, and 5,280 ft. long $= l$ and the current of water filling it be flowing at a uniform rate v of 5 feet per second. Then the momentum M of this column of water, due to its weight and velocity is —

$$\begin{aligned} M &= .7854 d_1^2 \times w \times l \times \frac{v^2}{2g} \\ &= .7854 \times 62.5 \times 5280 \times .3882. \\ &= 100{,}614.\ 45 \text{ lbs.} \end{aligned}$$

If the valve is closed and the flow checked instantaneously, this great force will act upon the valve and upon the shell of the pipe. If the given length of the column of water in motion is doubled or quadrupled, the force of the ram will be doubled or quadrupled.

A STATEMENT

Of the number of gallons used per day (per capita) in the principal cities of this and foreign countries. This statement has been compiled from reports of the different cities of the latest date.

United States.		*Foreign.*	
Pittsburg,	100	Dublin,	60
New York,	90	Glasgow,	52
Detroit,	88	Paris,	38
Chicago,	80	Edinburgh,	35

United States.	
Hartford,	80
Reading,	75
New Haven,	75
Albany,	70
Springfield,	66
Buffalo,	63
Boston,	60
Brooklyn,	60
Philadelphia,	56
Toledo,	54
Cincinnati,	53
Baltimore,	50
Lowell,	44
St. Louis,	44
Cleveland,	43
Providence,	30
Milwaukee,	25
Cambridge,	43
Charlestown,	43
Jersey City,	83
Louisville,	28
Montreal,	49
Newark,	20
New Orleans,	30
Salem,	41
Washington,	127
Worcester,	48
Lancaster, Penn.,	112
Taunton,	20
Newton,	21
Fall River,	27
Pawtucket,	32
Lynn,	35
Lawrence,	38
New Bedford,	76

Foreign.	
London,	33
New Castle,	28
Exeter,	25
Preston,	24
Leeds,	23
Manchester,	21
Birmingham,	20
Sheffield,	20
Derby,	20
Sunderland,	19
Nottingham,	18
Bristol,	18
Bath,	16
Norwich,	14
Cambridge,	13
Huddersfield,	10
Gosport,	10
Liverpool,	27
Marseilles,	40
Genoa,	30
Geneva,	16
Madrid,	16
Berlin,	18
Hamburg,	34

TABLE showing the Consumption of Water in

CITIES.	Year.	Population.	System of Supply.
Taunton,	1879,	20,000	Steam power.
Newton,	"	17,300	"
Fall River,	"	47,000	"
Providence,	"	100,000	"
Pawtucket,	"	25,000	"
Lynn,	"	36,000	"
Lowell,	"	50,000	"
Lawrence,	"	38,000	"
Cambridge,	"	50,000	"
Worcester,	"	50,000	Gravity.
St. Louis,	1877,	400,000	Steam power.
Salem,	1879,	34,400	"
Cincinnati,	1878,	280,000	"
Philadelphia,	"	850,000	Water & steam.
Brooklyn,	1877,	485,000	Steam power.
Boston (Cochituate),	1879,	340,000	Gravity.
" (Mystic),	"	110,000	Steam power.
" (Cochituate and Mystic),	"	450,000	Gravity & steam.
New York,	1878,	1,050,000	Gravity.
Chicago,	1877,	440,000	Steam power.
New Bedford,	1879,	27,200	"
Columbus,	1880,	51,665	"
Pittsburg,	1879,	156,381	"
Washington,	1880,	147,307	Gravity.
Minneapolis,	"	46,887	Water power.
Louisville,	1879,	123,645	Steam power.
Cleveland,	1877,	136,000	"
Detroit,	"	110,000	"
Buffalo,	"	135,000	"
Milwaukee,	1879,	116,000	"

Different Cities, and the Receipts for the Same.

Average daily consumption. Gallons.	Daily consumption per capita.	Miles of pipe.	Number of meters in use.	Number of serv.-pipes in use.	Per cent. of service-pipes with meters.	Total receipts for water.	Receipts per million gallons.
394,061	20	27.63	188	1,370	14	$23,306 85	$162 04
355,925	21	51.25	358	1,917	18	27,155 52	209 02
1,263,923	27	52.05	1,878	2,497	55	69,691 46	151 04
3,110,279	31	152.04	4,036	8,656	47	229,557 78	202 23
802,467	32	48.	588	1,400	42	18,320 17	62 55
1,267,827	35	52.53	118	4,127	3	73,791 47	159 81
1,890,181	38	57.54	377	4,714	8	99,569 84	144 32
1,456,080	38	40.68	209	2,978	7	58,287 40	109 68
2,432,386	49	79.	134	7,145	2	168,000 00	189 23
2,500,000	50	77.50	3,481	4,984	70	73,149 40	80 16
22,349,443	56	185.	350	16,800	2	494,629 74	60 60
1,939,048	56	43.28	120	4,428	3	48,937 22	69 14
17,120,338	61	178.90	406	20,600	2	451,958 94	72 03
52,333,826	62	722.34	16	-	-	1,376,582 05	72 06
30,342,900	63	388.30	930	54,879	2	1,005,842 14	90 90
25,695,900	75	313.	1,100	41,000	3	-	-
3,384,460	81	172.	156	-	-	-	-
34,580,360	77	485.	1,256	-	-	1,237,256 23	98 03
93,400,000	89	463.70	5,000	77,400	-	1,606,509 29	47 12
52,183,900	119	425.	1,623	64,898	3	908,509 64	47 70
2,056,311	76	40.35	23	3,370	1	38,031 21	50 67
2,159,827	42	50.5	534	-	-	48,228 41	61 19
16,021,624	100	105.5	-	-	-	312,084 66	73 13
-	-	175.1	-	-	-	110,005 15	-
2,628,569	56	18.6	-	-	-	16,008 72	16 69
6,578,670	53	-	-	-	-	176,097 45	93 27
7,726,920	56	-	248	7,760	-	152,794 00	54 00
11,543,120	105	-	9	18,754	-	210,288 00	50 00
11,691,200	87	-	-	6,380	-	189,296 00	44 00
10,603,867	124	-	101	6,835	-	121,555 00	31 00

TABLE showing Amounts Paid for Water by a

CITIES.	Family rate.	Pan closet.	Bath tub.
Columbus, Ohio, ...	$9 00	$3 00	$3 00
Lawrence, Mass., ...	5 00	4 00	3 00
Lynn, Mass., ...	6 00	5 00	5 00
Fitchburg, Mass., ...	6 00	5 00	5 00
Newton, Mass., ...	6 00	5 00	5 00
Cambridge, Mass., ...	7 00	6 00	6 00
Providence, R. I., ...	6 00	5 00	5 00
Taunton, Mass., ...	5 00	5 00	8 00
Lowell, Mass., ...	6 00	4 00	8 00
Fall River, Mass., ...	5 00	5 00	5 00
Brooklyn, N. Y., ...	16 00	2 00	-
Albany, N. Y., ...	18 00	2 00	-
Buffalo, N. Y., ...	20 00	8 00	5 00
Niagara Falls, N. Y., ...	9 00	3 00	8 00
Detroit, Mich., ...	7 00	3 00	2 00
Cincinnati, Ohio, ...	14 00	8 00	6 00
Cleveland, Ohio, ...	10 00	5 00	2 50
Toledo, Ohio, ...	10 25	2 50	3 50
Chicago, Ill., ...	19 00	5 00	3 00
Alton, Ill., ...	7 00	5 00	8 00
Philadelphia, Penn., ...	8 75	2 00	3 00
Pittsburg, Penn., ...	27 77	7 55	10 85
Milwaukee, Wis., ...	11 50	5 00	8 00
Salem, Mass., ...	8 50	5 00	5 00
Concord, N. H., ...	6 00	3 00	8 00
Hartford, Conn., ...	5 00	8 00	1 00
Louisville, Ky., ...	10 00	3 00	4 00
Grand Rapids, Mich., ...	8 00	4 50	8 75
Springfield, Mass., ...	8 00	4 00	4 00

Family Occupying a Large House in Different Cities.

Wash-stand or 2d faucet.	Wash-tub.	Horse and carriages, with use of hose.	Cow.	Hose, single rate.	Total.
-	-	$3 50	-	$5 00	$23 50
-	$1 00	3 00	$1 50	2 50	20 00
$2 00	2 00	5 00	1 50	3 00	29 50
2 00	2 00	8 00	2 00	5 00	35 00
2 00	1 00	10 00	1 50	5 00	35 50
2 50	2 50	5 00	2 00	10 00	41 00
2 00	3 00	4 00	1 00	5 00	31 00
2 00	2 00	4 00	1 50	5 00	27 50
-	1 00	4 00	2 00	3 00	23 00
2 50	2 50	4 00	1 00	6 00	31 00
-	-	5 00	75	5 50	29 25
-	-	3 00	-	8 00	31 00
-	-	4 00	1 50	5 00	43 50
-	-	3 00	1 50	6 00	25 50
1 25	2 00	4 00	1 00	3 00	23 25
1 00	-	5 00	-	4 80	33 80
-	-	2 50	-	1 50	21 50
2 00	-	5 00	-	5 00	28 25
-	-	4 00	-	3 00	34 00
-	-	8 00	2 00	9 00	39 00
1 00	1 00	3 00	-	9 00	27 75
3 25	-	8 25	2 05	6 87	71 50
2 00	-	4 00	1 00	8 00	34 50
1 50	-	6 00	1 00	3 00	24 00
1 00	-	2 00	1 00	3 00	19 00
-	-	4 00	1 00	5 00	19 00
-	1 00	5 00	1 00	7 50	31 50
2 00	3 00	2 50	1 00	2 00	26 75
-	-	4 00	2 00	5 00	27 00

LIST OF WATER WORKS IN THE UNITED STATES AND CANADAS.

January 1, 1881.

Compiled by E. Prince, C. E., Quincy, Ill.

(Those marked * are private enterprises.)

Birmingham,*	Ala.
Huntsville,	“
Jacksonville,	“
Mobile,*	“
Montgomery,*	“
Prescott,	Arizona Ter.
Little Rock,*	Ark.
Anaheim,	Cal.
Columbia,	“
Dutch Flat,	“
Gilroy,*	“
Grass Valley,	“
Los Angeles,*	“
Marysville,*	“
Modesto,	“
Mission San José	“
Nevada City,	“
Oakland,*	“
Petaluma,*	“
Placerville,	“
Red Bluff,	“
Sacramento,	“
Santa Barbara,*	“
San Francisco,*	“
San José,*	“
San Quinlan,	“
San Rafael,*	“
Salinas City,	“
San Diego,	“
Stockton,	“
Santa Cruz,	“
Vallejo,*	Cal.
Watsonville,	“
Washington, Yolo Co.,	“
Woodford, “	“
Yreka,	“
Ansonia,*	Conn.
Bethel,	“
Birmingham,*	“
Bridgeport,*	“
Danbury,	“
Greenwich,	“
Hartford,	“
Meriden,	“
Middletown	“
Milford,	“
New Britain,	“
New Haven,*	“
New London,	“
New Milford,	“
Norwalk,	“
Norwich,	“
Rockville,*	“
Shelton,	“
South Norwalk,	“
Stamford,*	“
Stonington,	“
Walcottville,*	“
Waterbury,	“
Winsted,	“
Bodie,	Col.
Boulder,	“

Caribou,	Col.
Cañon City,*	"
Central City,*	"
Colorado Springs,	"
Denver,*	"
Golden,	"
Leadville,*	"
Pueblo,	"
Silver Cliff,	"
Trinidad,*	"
Deadwood,	Dakota.
Newcastle,*	Del.
Wilmington,	"
Washington,	D. C.
Jacksonville,	Fla.
Atlanta,	Ga.
Augusta,	"
Rome,	"
Savannah,	"
Silver City,	Idaho Territory.
Alton,*	Ill.
Bloomington,	"
Charleston,	"
Chicago,	"
Decatur,	"
DeKalb,	"
Dixon,	"
Elgin,	"
Evanston,	"
Hyde Park,	"
Jacksonville,	"
Lake,	"
Lake View,	"
Litchfield,	"
Moline,	"
Oregon,	"
Paris,	"
Pekin,	"
Peoria,	"
Quincy,*	"
Rochelle,	"
Rockford,	"
Rock Island,	"
Springfield,	"
Sterling,	"
Sycamore,	Ill.
Waukegan,	"
Attica,	Ind.
Brazil,	"
Brookville,	"
Columbus,	"
Connersville,	"
Evanston,	"
Evansville,	"
Fort Wayne,	"
Indianapolis,*	"
Jeffersonville,	"
Kokomo,	"
La Fayette,	"
Laporte,	"
Logansport,	"
Madison,	"
Marion,	"
Michawakee,	"
New Albany,*	"
New Carlisle,	"
Peru,	"
South Bend,	"
Terre Haute,*	"
Union City,	"
Washington,	"
Anamosa,*	Ia.
Atlantic,	"
Burlington,*	"
Cedar Rapids,*	"
Clinton,*	"
Davenport,*	"
Des Moines,*	"
Dubuque,*	"
Keokuk,*	"
Lyons,*	"
Marengo,	"
Marshalltown,	"
Monticello,	"
Mt. Pleasant,	"
Muscatine,*	"
Oskaloosa,	"
Ottumwa,*	"
State Centre,	"
Blue Rapids,	Kan.

Emporia,	Kan.
Fort Scott,	“
Bowling Green,	Ky.
Covington,	“
Frankfort,	“
Henderson,	“
Louisville,*	“
Maysville,	“
Newport,	“
Owensboro,	“
Pleasant Hill,	“
New Orleans,	La.
Auburn,*	Me.
Augusta,*	“
Bangor,	“
Belfast,	“
Biddeford,*	“
Houlton,	“
Lewiston,	“
Portland,*	“
Rockland,*	“
Waterville,	“
Annapolis,*	Md.
Baltimore,	“
Cumberland City,*	“
Frederick,	“
Frostburg,	“
Morganza,	“
Amherst,	Mass.
Arlington,	“
Athol,*	“
Attleboro,	“
Beverly,	“
Boston,	“
Brighton,	“
Brockton,	“
Brookline,	“
Cambridge,	“
Charlestown,	“
Chelsea,	“
Cheshire,	“
Chicopee,*	“
Concord,	“
Danvers,	“
Easthampton,	“
East Saugus,	Mass.
Everett,	“
Fall River	“
Fitchburg,	“
Great Barrington,*	“
Greenfield,	“
Haverhill,*	“
Hingham,	“
Holyoke,	“
Kingston,*	“
Lawrence,	“
Lenox,*	“
Leominster,	“
Lincoln,	“
Lowell,	“
Lynn,	“
Malden,	“
Medford,	“
Melrose,	“
Methuen,	“
Marblehead,	“
Middleboro,	“
Milford,	“
Natick,	“
Nantucket,	“
New Bedford,	“
Newburyport,	“
Newton,	“
North Adams,	“
Northbridge,	“
Northampton,	“
Orange,	“
Peabody,	“
Pittsfield,	“
Plymouth,	“
Quincy,	“
Reading,	“
Salem,	“
Shelburne Falls,	“
Somerville,	“
South Adams,	“
South Hadley,	“
South Lee,*	“
Springfield,	“
Stockbridge,*	“

Taunton,	**Mass.**
Warren,	"
Watertown,	"
Waltham,	"
Westborough,	"
West Brookfield,*	"
Westfield,	"
West Springfield,	"
Winchester,	"
Woburn,	"
Worcester,	"
Adrian,	**Mich.**
Allegan,	"
Almont,	"
Alpena,	"
Ann Arbor,	"
Bay City,	"
Big Rapids,	"
Cadillac,	"
Constantine,	"
Detroit,	"
East Saginaw,	"
Grand Haven,	"
Grand Rapids,	"
Holly,	"
Ionia,	"
Jackson,	"
Kalamazoo,	"
Marquette,	"
Muskegan,	"
Niles,*	"
Plainfield,	"
Plainwell,	"
Port Huron,	"
Portland,	"
Saginaw,	"
St. Louis,	"
Tecumseh,	"
Warmouth,	"
West Bay City,	"
Mankato,	**Minn.**
Minneapolis,	"
St. Paul,*	"
Stillwater,	"
Winona,	"
Columbus,	**Miss.**
Carthage,	**Mo.**
Hannibal,*	"
Kansas City,*	"
Sedalia,	"
St. Joseph,*	"
St. Louis,	"
Joplin,	"
Omaha,*	**Neb.**
Nebraska City,	"
Grand Island,	"
Austin City,	**Nev.**
Eureka,*	"
Gold Hill,*	"
Hamilton,	"
Pioche,*	"
Virginia City,*	"
Bethlehem,	**N. H.**
Claremont,*	"
Concord,	"
Dover* (3 com.),	"
Farmington,	"
Great Falls,	"
Keene,	"
Manchester,	"
Nashua,*	"
Portsmouth,*	"
Atlantic City,	**N. J.**
Bergen,	"
Bloomfield,	"
Bridgeton,	"
Bordentown,*	"
Burlington,	"
Camden,	"
Cape May,	"
Elizabeth,*	"
Flemington,	"
Hackensack,*	"
Hackettstown,	"
Hudson City,	"
Jersey City,	"
Lambertville,	"
Long Branch,	"
Millville,*	"
Morristown,*	"

Mt. Holly,*	N. J.
Newark,	"
New Brunswick,	"
Passaic,*	"
Paterson,*	"
Phillipsburg,*	"
Rahway,	"
Trenton,	"
Albany,	N. Y.
Andes,	"
Attica,	"
Auburn,*	"
Avon,*	"
Ballston Spa,	"
Batavia,	"
Bayside,	"
Binghamton,	"
Brooklyn,	"
Buffalo,	"
Canajoharie,	"
Clifton Springs,	"
Cohoes,	"
College Point,	"
Cooperstown,*	"
Corning,*	"
Dansville,	"
Delhi,*	"
Dunkirk,*	"
Edgewater,	"
Ellenville,	"
Elmira,*	"
Flushing,	"
Ft. Edward,*	"
Fredonia,	"
Garden City,*	"
Geneseo,	"
Geneva,*	"
Glen's Falls,	"
Gloversville,	"
Goshen,	"
Governeur,*	"
Hudson,	"
Ithaca,*	"
Jamestown,*	"
Johnstown,	"
Leroy,	N. Y.
Lockport,*	"
Long Island City,	"
Lyons,	"
Malone,	"
Medina,	"
Middletown,	"
Newburg,	"
New York City,	"
Niagara Falls,*	"
Norwich,	"
Ogdensburg,	"
Oswego,*	"
Owego,*	"
Peekskill,	"
Port Byron,	"
Port Jervis,*	"
Port Richmond,	"
Potsdam,	"
Poughkeepsie,	"
Prospect Park,	"
Plattsburgh,	"
Richfield Springs,	"
Rochester,	"
Rome,	"
Saratoga Springs,	"
Schenectady,*	"
Suspension Bridge,	"
Susquehanna,	"
Syracuse,*	"
Tennytina,	"
Tonawanda,	"
Troy,	"
Utica,*	"
Walton,*	"
Whitehall,	"
Warwick,	"
Warsaw,*	"
Watertown,	"
Waverly,	"
West Troy,*	"
Yonkers,	"
Fayetteville,	N. C.
Salem,	"
Akron,	Ohio.

Alliance,	Ohio.
Bellair,	"
Bellevue,	"
Canton,	"
Cincinnati,	"
Cleveland,	"
Columbus,	"
Crestline,	"
Dayton,	"
East Liverpool,	"
Elyria,	"
Galion,	"
Hamilton,	"
Ironton,	"
Lancaster,	"
Mansfield,	"
Massillon,*	"
Middletown,	"
New Lisbon,	"
Norwalk,	"
Piqua,	"
Portsmouth,	"
Salem,	"
Sandusky,	"
Sidney,	"
Steubenville,	"
Tiffin,	"
Toledo,	"
Urbana,*	"
Warren,	"
West Cleveland,	"
Wooster,	"
Youngstown,	"
Zanesville,	"
Portland,*	Or.
Salem,	"
The Dalles,	"
Allegheny,	Pa.
Allentown,	"
Altoona,	"
Archibald,*	"
Ashland,	"
Beaver Falls,*	"
Bedford,	"
Bellfonte,	"
Bethlehem,	Pa.
Berwick,*	"
Birmingham,	"
Bloomsburg,	"
Blairsville,	"
Boyerstown,	"
Bristol,*	"
Butler,	"
Carbondale,	"
Carlisle,*	"
Catasauqua,	"
Chambersburg	"
Chester,	"
Clarion,	"
Coatesville,	"
Columbia,*	"
Connemaugh,	"
Conshohocken,*	"
Corry,	"
Danville,	"
Downingtown,*	"
Doylestown,	"
Dunmore,	"
Easton,*	"
Ebensburg,	"
Ephrata,	"
Erie,	"
Franklin,*	"
Germantown,	"
Gettysburg,	"
Hamorton,	"
Hanover,	"
Harrisburg,	"
Hazelton,*	"
Holidaysburg,	"
Housedale,	"
Huntingdon,	"
Jamestown,	"
Johnstown,*	"
Kennett Square,	"
Kittanning,	"
Lancaster,	"
Lansford,*	"
Lebanon,*	"
Lewistown,	"

Lockhaven,	Pa.
Louella,*	"
Mahanoy City,*	"
Mauch Chunk,*	"
Meadville,*	"
Mechanicsburg,	"
Media,	"
Milford,*	"
Minersville,*	"
Monongahela,	"
Mt. Job,	"
New Brighton,	"
Norristown,*	"
Oil City,	"
Oxford,	"
Parker City,	"
Philadelphia,	"
Phœnixville,	"
Pittston,*	"
Pittsburgh,	"
Plymouth,*	"
Pottstown,*	"
Pottsville,*	"
Providence,*	"
Reading,	"
Renovo,	"
Reynoldsville,	"
Sewickley,	"
Scranton,*	"
Shamokin,*	"
Sharon,	"
Shenandoah,	"
Slatington,	"
South Bethlehem,*	"
Stroudsburg,	"
Summit Hill,*	"
Susquehanna,*	"
Tamaqua,	"
Tioga,	"
Titusville,	"
Towanda,	"
Tunkhannock,*	"
Tyrone,	"
West Chester,	"
West Pittston,	"
Wilkesbarre (2 companies),*	Pa.
Williamsport (2 companies),*	Pa.
York,	Pa.
Bristol,	R. I.
Central Falls,	"
Newport,*	"
Pawtucket,	"
Providence,	"
Charleston,	S. C.
Columbia,*	"
Chattanooga,*	Tenn.
Clarksville,*	"
Columbia,	"
Memphis,*	"
Nashville,	"
Austin,*	Tex.
Dallas,*	"
Dennison,	"
Galveston,	"
Houston,	"
San Antonia,*	"
Sherman,	"
Waco,*	"
Salt Lake City,	Utah,
Park City,	"
Logan City,	"
Bellows Falls,	Vt.
Brandon,	"
Burlington,	"
Fair Haven,	"
Hyde Park,*	"
Rutland,	"
St. Albans,	"
St. Johnsbury,	"
Vergennes,	"
Windsor,	"
Worcester,	"
Alexandria,*	Va.
Charlottesville,	"
Danville,*	"
Fredericksburg,	"
Lexington,	"
Lynchburg,	"
Norfolk,	"
Petersburg,	"

Richmond,	**Va.**
Staunton,	"
University of Virginia,	"
Winchester,	"
Olympia,	**Wash. Ter.**
Seattle,	"
Vancouver,	"
Walla Walla,*	"
Martinsburg,	**W. Va.**
Wheeling,	"
Beloit,	**Wis.**
Janesville,	"
Kenosha,	"
La Crosse,	"
Milwaukee,	"
Prairie du Chien,	"
Racine,	"
Sparta,	"
Cheyenne,	**Wyo. Ter.**
Barrie,	**Can.**
Berthier,	"
Brantford,*	"
East London,	"
Kingston,	"
London (Ont.),	**Can.**
Mitchell,	"
Montreal,	"
Ottawa,	"
Owen Sound,	"
Quebec,	"
Halifax (N. S.),	"
Hamilton (Ont.),	"
Sarnia,	"
Seaforth,	"
Sorel,	"
St. Catharines,	"
St. Cunegonde,	"
St. Gabriel,	"
St. Thomas,	"
St. John (N. B.),	"
Three Rivers,	"
Toronto,	"
Truro,	"
Walkertown,	"
Windsor,	"
Wingham,	"
Yorkville,	"
Yarmouth,	"

TABLE OF WATER PRESSURE

Of Cities and Towns in the United States.

[By kind permission of the Baker Water Motor Company.]

STATES, CITIES, AND TOWNS.	Highest.	Lowest.	Average.
Massachusetts.			
Boston,	-	-	50
Beverly,	-	-	37
Brookline,	100	-	-
Cambridge,	-	-	40
Chelsea,	-	-	40
Fall River,	115	20	-
Lawrence,	-	-	70
Lynn,	-	-	65
Leominster,	-	-	80
Lowell,	-	-	55
Malden,	-	-	50
New Bedford,	-	-	35
North Adams,	-	-	70
Northampton,	-	-	90
Pittsfield,	60	-	45
Plymouth,	-	-	25
Salem,	-	-	50
Springfield,	125	-	40
Taunton,	-	-	37
Waltham,	-	-	60
Woburn,	-	-	60
Worcester,	165	80	-

TABLE OF WATER PRESSURE — Continued.

STATES, CITIES, AND TOWNS.	Highest.	Lowest.	Average.
Indiana.			
Evansville,	150	30	-
Indianapolis,	120	45	-
Lafayette,	110	50	-
Logansport,	80	40	40
New Albany,	85	70	-
South Bend,	100	50	-
Terre Haute,	100	35	-
Iowa.			
Burlington,	-	-	90
Cedar Rapids,	60	40	-
Des Moines,	85	10	-
Dubuque,	40	20	-
Marshalltown,	200	50	-
Muscatine,	-	-	75
Ottumwa,	110	90	-
Wisconsin.			
La Crosse,	100	40	-
Milwaukee,	85	13	-
Michigan.			
Saginaw,	100	40	-
Kalamazoo,	50	45	-
Bay City,	125	20	-
Detroit,	47	5	-
Grand Rapids,	70	10	-
Port Huron,	200	25	-
Muskegon,	90	40	-
Jackson,	55	12	-

TABLE OF WATER PRESSURE — Continued.

STATES, CITIES, AND TOWNS.	Highest.	Lowest.	Average.
Maine.			
Auburn,	–	–	55
Augusta,	60	25	–
Bangor,	110	90	–
Portland,	100	60	–
New Hampshire.			
Concord,	–	–	45
Manchester,	–	–	60
Nashua,	–	–	45
Portsmouth,	–	–	25
Keene,	–	–	58
Vermont.			
St. Albans,	–	–	100
Rhode Island.			
Providence,	70	39	–
Pawtucket,	120	60	–
Connecticut.			
Hartford,	–	–	50
New Haven,	–	–	35
Bridgeport,	–	–	35
Waterbury,	–	–	90
Danbury,	–	–	75
Norwich,	–	–	75
New London,	70	50	–
New Britain,	–	–	70
West Meriden,	–	–	100

TABLE OF WATER PRESSURE — Continued.

STATES, CITIES, AND TOWNS.	Highest.	Lowest.	Average.
New York.			
Troy,	–	–	20
Auburn,	–	–	45
Binghamton,	–	–	35
Brooklyn,	–	–	30
Elmira,	–	–	28
Hudson,	–	–	90
Lockport,	–	–	60
Newburgh,	120	65	–
Ogdensburg,	–	–	40
Poughkeepsie,	–	–	70
Rochester,	–	–	50
Syracuse,	–	–	35
Watertown,	90	–	60
Schenectady,	80	65	–
Rome,	–	–	25
Peekskill,	163	–	121
New Jersey.			
Bordentown,	–	–	35
Elizabeth,	–	–	15
Jersey City,	–	–	35
New Brunswick,	56	21	–
Paterson,	–	–	30
Rahway,	75	45	–
Trenton,	–	–	25
Pennsylvania.			
Allentown,	197	20	–
Allegheny,	–	–	35
Bristol,	–	–	40
Easton,	–	–	80

TABLE OF WATER PRESSURE — Continued.

STATES, CITIES, AND TOWNS.	Highest.	Lowest.	Average.
Erie, ...	90	–	–
Hanover, ...	–	–	85
Johnstown, ...	–	–	55
Lancaster, ...	–	–	65
Meadville, ...	130	75	–
Philadelphia, ...	–	–	15
Pottsville, ...	90	–	–
Pittsburg, ...	–	–	40
Scranton, ...	–	–	50
Titusville, ...	–	–	40
Wilkesbarre, ...	–	–	40
Delaware.			
Wilmington, ...	–	–	40
Maryland.			
Annapolis, ...	–	–	35
Baltimore, ...	100	–	–
Cumberland, ...	–	–	80
Frederick, ...	–	–	25
Virginia.			
Danville, ...	85	10	–
Lynchburg, ...	–	–	50
Norfolk, ...	–	–	40
Richmond, ...	75	13	–
West Virginia.			
Wheeling, ...	–	–	51

TABLE OF WATER PRESSURE — Continued.

STATES, CITIES, AND TOWNS.	Highest.	Lowest.	Average.
Dist. of Columbia.			
Washington, ...	–	–	20
South Carolina.			
Columbia, ...	–	–	40
Georgia.			
Atlanta, ...	90	–	40
Augusta, ...	50	27	–
Macon, ...	32	–	–
Ohio.			
Canton, ...	–	–	45
Cleveland, ...	–	–	30
Columbus, ...	–	–	35
Dayton, ...	100	–	50
Sandusky, ...	–	–	50
Tiffin, ...	–	–	45
Youngstown, ...	–	–	70
Zanesville, ...	–	–	60
Illinois.			
Alton, ...	100	–	80
Chicago, ...	–	–	27
Peoria, ...	–	–	60
Quincy, ...	–	–	85
Rockford, ...	–	–	50
Springfield, ...	50	10	–

TABLE OF WATER PRESSURE — Continued.

STATES, CITIES, AND TOWNS.	Highest.	Lowest.	Average.
Missouri.			
Hannibal,	95	80	-
St. Joseph,	119	47	-
Kansas City,	130	40	-
California.			
San Francisco,	90	10	-
San José,	-	-	45
Los Angeles,	45	20	-

The Continental

WATER METER COMPANY.

P. A. COLLINS, . President.

JOHN D. GOULD, Treasurer and Manager.

OFFICE:

NO. 95 MILK STREET, ROOMS 64 AND 65,

New York Mutual Life Insurance Company Building,

BOSTON, MASS.

Testimonials furnished on application.

Correspondence solicited.

Meters furnished for trial, to be returned if not satisfactory.

[SEE NEXT PAGE.]

ADDRESS:

JOHN D. GOULD,

MANAGER,

95 MILK STREET, BOSTON, MASS.

THE

CONTINENTAL

WATER METER COMPANY

ARE PREPARED TO FURNISH

METERS UNDER GUARANTEE

TO PERFORM ANY DUTY REQUIRED OF A WATER METER,
UNDER ALL THE VARYING PRESSURE, AND AT
PRICES THAT DEFY COMPETITION.

Having recently become the Owner of

ALL THE PATENTS COVERING WATER METERS

that are of ANY VALUE and to be relied upon for

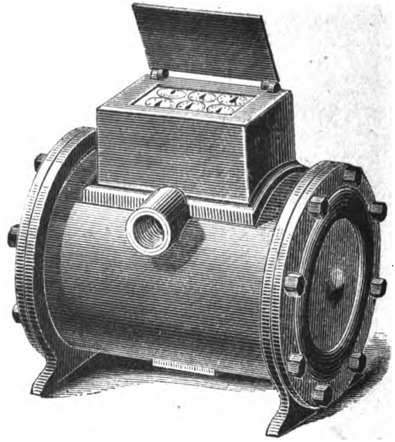
ACCURACY AND DURABILITY

we can positively assure the public that all Meters purchased of us, or
of our Agents, will receive the fullest guarantee covering
the duty required and absolute protection
in the use of the same.

Our Patents date from 1865 to the Present Year.

Having Meters that have been in constant use for ten years, we feel
justified in making the positive statement that we can
substantiate our claim for

DURABILITY, ACCURACY, AND SIMPLICITY.



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A pure water and its preservation.
Cabot Science 004965535
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